The Martian Chronicle

Issue 9 — A Publication of the Mars Exploration Program at JPL — November 1998

Letter From the Editor

Welcome back to *The Martian Chronicle*. After a very long absence, we are again alive and well. As most of you may know, our last editor, David Dubov, left JPL for greener pastures last year. Now, under new direction, we are setting forth a new trail in the exploration of Mars.

Since our last newsletter, the Mars Exploration Office at JPL has been quite busy making changes. Of the two spacecraft launched before our last issue (April 1997), only Mars Global Surveyor still remains alive. Gone is the tremendously successful Mars Pathfinder spacecraft with its sidekick Sojourner, put quietly to rest in March 1998 when the last attempt failed to communicate with the lander. But do not fret; the success of the Pathfinder mission left a legacy of goals for future missions to achieve. On the Internet alone, over 86 million people visited our site in a three-month span, surpassing any known Internet record of its time. Rocks such as Yogi, Scooby Doo, and Barnacle Bill are now as well known on Mars as the Grand Canyon is on Earth. The "little mission that couldn't" went well beyond what we ever imagined.

But the completion of Pathfinder does not mean the end of Mars exploration. Final preparations are now under way for the next two launches of spacecraft to Mars at the end of this year. Future Mars missions are under development. Madame Curie, Sojourner's twin sister, is being proposed to fly on 2001. Athena, the next-generation rover, will fly on 2003, and a sample return mission is planned for 2005. These are thrilling times for Mars exploration, and *The Martian Chronicle* will be there to keep you posted about our missions. Stay tuned and climb aboard with us for the next journey to Mars.

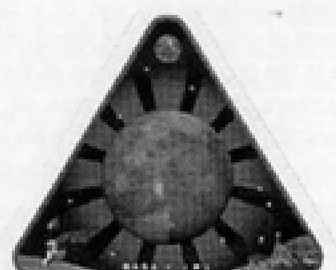
Dr. Bob Anderson
MEP

Two Mars '98 Spacecraft Near Launch

The Mars Surveyor '98 mission is the third in NASA's Mars Surveyor Program to explore the mysterious Red Planet between 1997 and 2007. Mars Surveyor '98 is comprised of two spacecraft, the Mars Climate Orbiter and the Mars Polar Lander. The lander is destined for the south polar region of Mars, equipped with an array of science instruments designed to search for water and volatile materials in the soil and atmosphere, which may provide clues to the climate of Mars in the distant past. The orbiter will observe the atmosphere of Mars on a global scale, using specialized instruments to measure its composition and behavior.

The Mars Climate Orbiter will be launched in the period December 10-23, 1998, from Cape Canaveral Air Force Station in Florida. After a nine-month journey, it will fire its main engine, braking into an elliptical, near-polar orbit. During the next two months, the orbiter will make many passes through the upper atmosphere of Mars to slow itself into a circular orbit with an altitude of just 410 km (255 miles) above the planet's surface. The orbiter will operate its instruments continuously over the course of a martian year (687 terrestrial days).

The Mars Polar Lander will be launched between January 3 and 27, 1999. Traveling at 6.9 km/s (15,400 mph), it will enter the martian atmosphere on December 3, 1999, after traveling nearly 930 million km (550 million miles) around the Sun. In only five minutes, the lander will decelerate from entry to a soft landing at about 2.2 m/s (5 mph), using an entry capsule and parachute for aerodynamic braking, followed



UNLOCKING MARS' HISTORY
MARS SURVEYOR 98

by a computer-controlled propulsive descent to touchdown. The lander will be targeted to the northernmost extent of a series of layered deposits in the south polar region, between 74 and 78 degrees south latitude. The lander's science experiments will be conducted during a three-month mission, beginning in late spring in the southern hemisphere (at arrival) and extending into early summer. The orbiter will also provide radio relay support to the lander during this period.

The Mars Surveyor '98 mission is managed for NASA by the Jet Propulsion Laboratory, California Institute of Technology.

Dr. Sam Thurman
Mars '98 Project

Mars Global Surveyor Update

Mars Global Surveyor (MGS) has been in orbit around Mars since September 11, 1997, and its first year at Mars has been filled with many significant events, a tantalizing first glimpse into Mars today, and a promise of startling discoveries to come as MGS begins mapping of the planet next year.

MGS was placed into a 45-hour elliptical orbit with a near-perfect orbit insertion maneuver to slow its cruise speed by 973.03 m/s, allowing it to be captured by Mars's gravity. The orbital period was only 45 seconds short of its nominal target!

Aerobraking, a process in which the spacecraft skims through the upper levels of the martian atmosphere at the closest approach to the planet in each orbit, slows the orbital speed slightly with each revolution about the planet. Eventually, the orbit changes from very elliptical (egg shaped) to circular and Sun synchronous with a period of only 2 hours, without the use of a large amount of propellant. The speed reduction is the result of the drag of the atmosphere on the large area of the spacecraft's solar panels, which are held rigidly in position during each drag pass.

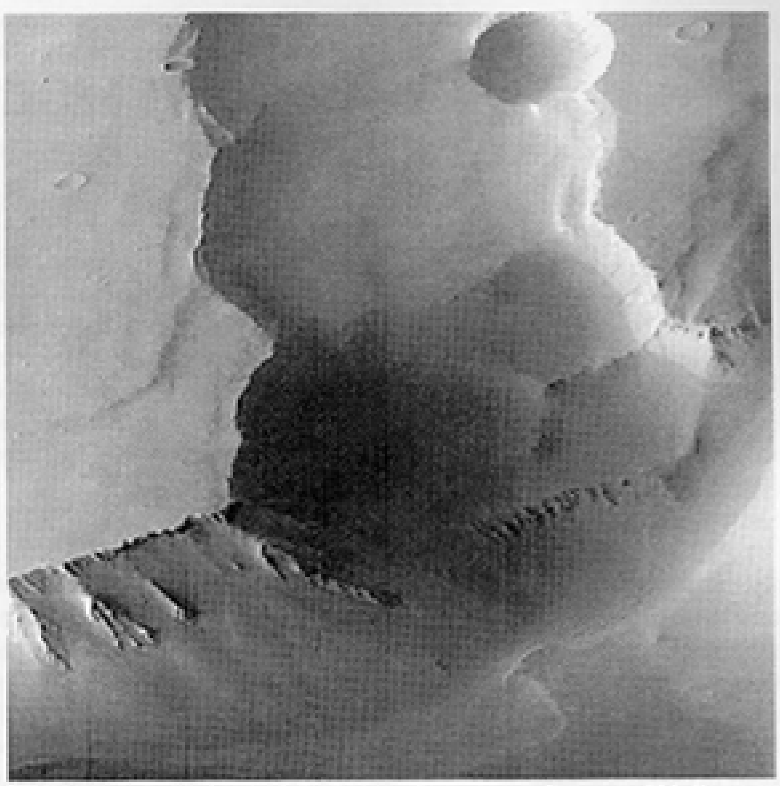
The science payload performed well, and science data acquisition was very successful during the early orbits. The Magnetometer experiment determined that there is no polar dipole magnetic field on Mars as there is on Earth, but instead there are numerous local remnant magnetic fields at various locations around the planet.

Aerobraking was initiated on September 16 with the first maneuver that began moving the periapsis or low portion of the orbit down into the top of the atmosphere. Aerobraking continued successfully until the 15th orbit, when the atmospheric density increased dramatically. This was not unexpected, but one of the spacecraft's solar panels behaved in an unexpected manner. Aerobraking was continued for several more orbits until it was determined that the solar panel motion might be an indication that we didn't fully understand the damage done to it during its abnormal deployment just after launch.

Through a very intense effort, the people who designed and built the spacecraft were able to determine a failure model that indicated that the triangular "yoke" structure that connects the solar panel to the main spacecraft structure had probably cracked. The solar panel motion that was being observed during aerobraking was the result of the yoke flexing about the crack. This then required that aerobraking not put so much stress on the solar panel and the yoke, so it would have to be done with less intensity. Less intense aerobraking would mean that the proper orbit conditions could not be obtained on the original mission schedule. That would be devastating to the science investigations, which require lighting on the martian surface equivalent to 2 p.m.

With this challenge, the people who designed the original mission were brought back onto the Project in order to find a mission plan that would be acceptable to the science investigations. True to their exceptional capabilities, they determined that if aerobraking was continued for three months at a lower intensity, then suspended for six months, and then started up again for a little more than four months, an orbital condition almost exactly like the original mapping plan could be accomplished. The only difference is that the spacecraft will be flying from the south pole to the north pole at 2 p.m. rather than from north to south. This change to the duration of aerobraking would delay the start of mapping for one year, but all the original mission objectives could be met!

With this new plan, aerobraking was resumed near the end of November 1997 and continued until the end of February 1998, when it was again suspended for six months in what was called the science phasing orbit period. All during this time, the science instruments acquired data. The spacecraft did a special rotation as it came to its clos-



MOC Image of Labyrinithus Noctis. (Image compliments of Malin Space Science Systems/NASA; #P005-03) est point to the planet on each orbit in order to provide good viewing for the cameras and the laser altimeter.

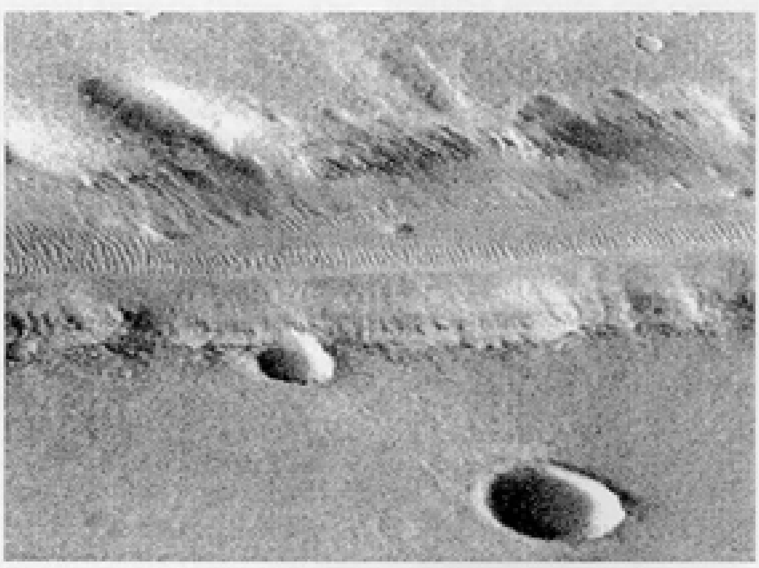
The science data obtained is really a bonus to the mission, as a large amount of data before the start of mapping was not part of the original mission plan. Many images of the martian surface, with better resolution than ever before, have been recorded. The laser altimeter has found the northern hemisphere of the planet to be very flat and has mapped the northern polar cap during its period of greatest extent. Several opportunities were taken to look at controversial features in the Cydonia region and at the larger of the two martian moons, Phobos.

Aerobraking was resumed again on September 14. Over the next four months the orbital period will be reduced from the current 11.6 hours to 2 hours and the orbit will become more and more circular. Because of the shorter orbital period, the opportunity to take additional science data will be limited until mapping begins in March 1999.

The flight operations project team is examining the expected performance of the deployment mechanism for MGS's high-gain antenna. Testing on some other spacecraft has indicated that the damper, which is designed to deploy the antenna in a slow and controlled manner, may in fact allow it to deploy too fast, perhaps resulting in some damage. In order to maximize the success of the MGS's mission, the flight team may elect to delay the deployment until after the first, most important, mapping data has been returned from the spacecraft. They may even wait until MGS has provided its radio relay support to the lander and penetrators of the next Surveyor mission to Mars, which lands in December 1999. Otherwise, the MGS spacecraft and its science payload are in excellent condition and have been performing very well.

The Mars Surveyor Operations flight team, which operates MGS, is ready for and looking forward to the completion of aerobraking. This team will also operate the Mars Climate Orbiter and Mars Polar Lander, which launch in December 1998 and January 1999, so a very busy year of space-

Glenn E. Cunningham
Manager, Mars Surveyor Operations Project



MOC Image of Nigel Valley (Image compliments of Malin Space Science Systems/NASA; #P006-05)

Scientific Results of the Mars Pathfinder Mission

Mars Pathfinder landed safely at 10 a.m. PDT on July 4, 1997, deployed and navigated a small rover, and collected data from three science instruments and ten technology experiments for three months. Although designed primarily as an entry, descent, and landing demonstration, the first low-cost, quick Discovery-class mission to be completed returned 2.3 billion bits of new data, including over 16,500 lander and 550 rover images, 16 chemical analyses of rocks and soil, and 8.5 million individual temperature, pressure, and wind measurements. The rover (named Sojourner) traversed 100 m clockwise around the lander, exploring about 200 m^2 of the surface. The mission captured the imagination of the public, garnered front-page headlines during the first week of mission operations, and went on to became one of NASA's most popular missions. A total of about 566 million Internet "hits" were registered during the first month of the mission, with 47 million hits on July 8 alone, making the Pathfinder landing by far the largest Internet event in history at the time.

The spacecraft was launched on December 4, 1996, and had a seven-month cruise to Mars. The vehicle entered the atmosphere directly following cruise stage separation. Parachute deployment, heatshield and lander separation, radar ground acquisition, airbag inflation, and rocket ignition all occurred before the landing at 2:58 a.m. true local solar time (9:56:55 a.m. PDT). The lander bounced at least 15 times up to 12 m high on one of the rockiest locations on Mars without airbag rupture, thereby demonstrating the robustness of this landing system. Unconnected disturbed soil patches indicate that the final few bounces of the lander were from the east-southeast and were followed by a gentle roll to

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Mars Pathfinder Loses a Friend

Henry J. Moore, Mars Geologist

Dr. Henry J. Moore, a U.S. Geological Survey geologist who helped to select the landing site for the Mars Pathfinder, died September 21 in Utah. At the time of his death, Moore and his wife Patsy Ann were en route from their home in Palo Alto, CA, to visit their daughter in Salt Lake City. Moore apparently died of a heart attack.

Moore was born in Albuquerque, NM, September 2, 1928. He grew up in Salt Lake City, attending elementary, secondary, and high schools there. In 1951 he received a bachelor's degree in mineralogy from the University of Utah. He received his graduate degrees from Stanford University: an MS in 1959 and a PhD in 1965.

He first became a U.S. Geological Survey summer employee as an undergraduate student, doing field mapping in Fallon, NV. Following graduation and service with the U.S. Navy, he returned to the USGS, doing geologic mapping in Grand Junction, CO.

In 1960, while attending Stanford, Moore ran into Eugene Shoemaker, whom he had first met when both were working for the USGS in Grand Junction. Shoemaker persuaded Moore to rejoin the USGS and become part of its fledgling astrogeology program. The rest, as they say, is history. Shoemaker and Moore became advisors to NASA and helped train Apollo astronauts in "crater geology," prior to the Moon landings of the 1960s. When those astronauts brought back rock samples from the Moon's surface, Moore was one of the scientists who helped in the analysis of those rocks and of photographs of the Moon's surface taken from lunar orbit.

Moore's experience in helping to select lunar landing sites and in astrogeology in general was transferred to the Mars Viking project, and he was among those who helped to select the landing site for the Viking that landed on Mars in 1976.

Moore retired from the USGS in 1994, but continued to work for the agency in a "scientist emeritus" position. He also served as a consultant to JPL, and on July 4, 1997, the Mars Pathfinder landed on a site that Moore had helped to select. Following the Pathfinder landing, Moore spent the next six weeks at JPL, working with other scientists on the JPL/NASA team to interpret the photos and other data that were being sent back by the Mars rover Sojourner, as she slowly and cautiously moved across the boulder-strewn plain at the mouth of Ares Vallis. Following the Pathfinder mission he received the NASA award for public service.

Moore is survived by his wife, Patsy Ann, of Palo Alto; two sons, Donald of San Francisco and Daniel, an employee of the U.S. State Department in Uganda; and a daughter, Laura Moore of Salt Lake City. Also surviving are his twin sister, Cynthia Fehr, and another sister, Elizabeth Jean Eliason, both of Salt Lake City.

Dr. Wes Ward
USGS

What's News in Mars Science

Studying Mars with Radar

Planetary radar astronomy, in which radio waves are bounced off planets and asteroids to study their surfaces, has been used to study Mars for 30 years. Radar information played a role in selecting the Viking and Pathfinder landing sites, and it will be used for future missions as well. Radar, an acronym for "radio detection and ranging," was first, and is still, used to refine our knowledge of the orbit and shape of Mars. The time of flight of a radio signal from Earth to Mars and back is measured in microseconds: a position precision of only hundreds of meters.

Mars is not a billiard ball, and so, when we look at a lot of echoes, we determine an average position of Mars's center of mass. The variation around this average is the martian topography at the subradar points, where the shortest radar-to-Mars distances are measured. The string of subradar points forms a radar track, and Mars radar astronomers have published topographic profiles along such tracks since before the Viking era.

Until the advent of the MOLA instrument on MGS, radar provided the best topographic information for Mars. Topography is an important parameter when choosing a landing site for a spacecraft. An extra few kilometers of thin Mars atmosphere can be critical to slowing an arriving lander.

Radar echoes provide information beyond straightforward ranging. The strength of the radio echo probes the geophysical parameters of the martian surface. A relatively flat and dense surface, like a dry lake bed on Earth, produces a strong mirror-like echo when viewed from directly overhead. If viewed from a slant, most of the incident radio energy will be reflected away from the direction back to the transmitter. A rolling surface, or a rough sur-

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Donna Shirley's Farewell to JPL

Hello and Goodbye from Donna Shirley, Mars Exploration Program Manager

I've been working on Mars on and off since 1965, intensely in the last 10 years, and I'm going to move on. Mars has been a fascination for me since I was about 12 years old and started reading science fiction like Arthur C. Clarke's "Sands of Mars" and Ray Bradbury's "Martian Chronicles." Over the past year I've seen my dreams come true with the success of Mars Pathfinder, the Sojourner Rover, and the Mars Global Surveyor Orbiter. The Mars Surveyor '98 orbiter and lander will launch within a few months, and future Mars missions are being planned.

Since 1994, when I became manager of the Mars Exploration Program, I've seen a collection of unrelated projects become linked with the objective of exploring Mars systematically, a piece at a time. The program has pioneered NASA's new "Better, Faster, Cheaper" philosophy, developing projects for a fraction of the cost of previous projects. Pathfinder and Mars Global Surveyor each cost less than a modern blockbuster movie. The two 1998 missions are being carried out for the price of Pathfinder. I was really gratified when a senior NASA manager said a couple of years ago: "The Mars Team has gone a long way toward convincing me that JPL really is doing business a new way."

I've been privileged over the last 32 years to work with some of the best, brightest, hardest working and most fascinating people in the world. JPL works at the cutting edge of engineering and science, sending robots where no robot has gone before. The summer and fall of 1997 with the Pathfinder and MGS successes were a pinnacle, and I have little more new to bring to the space program.

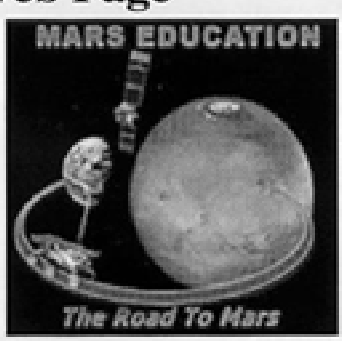
The last chapter of my autobiography, "Managing Martians," is called "Where Do You Go After You've Been to Mars?" I've been thinking a lot about that and have decided to retire from JPL to go in some new directions.

I'm going to finish the PhD in Human and Organizational Development (that's really a fancy name for management) that I've been dabbling with for a year. I'm doing a lot of speaking and am starting to develop a following as a management consultant. I'd like to apply the management and leadership skills I've learned to some new problems, like cleaning up the environment and making the world a better place for all of our children and grandchildren.

No one could have had better jobs than I have had, nor a better set of people to work with at JPL and to interact with in the space-loving public. The Mars Exploration Program will go on, orbiting, landing, roving, collecting and returning samples, and eventually people will go to Mars. I'll be following this Web site along with the rest of you to watch its progress. Thanks,

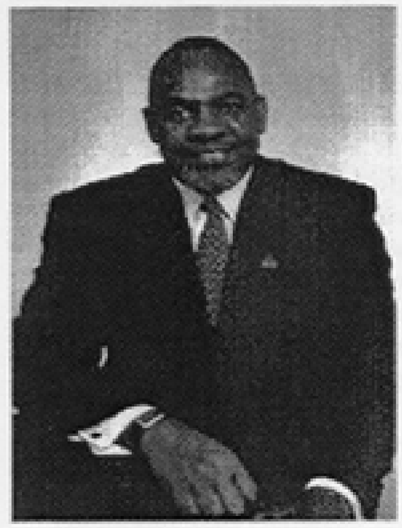
Donna Shirley
MEP

New Education Web Page



http://marsnt3.jpl.nasa.gov/education

Dr. Cheick Diarra Named UNESCO Ambassador



Dr. Cheick Diarra, who oversees educational outreach efforts for JPL's Mars Exploration Program Office, has been designated the 19th goodwill ambassador of the United Nations Educational, Scientific and Cultural Organization (UNESCO) to the continent of Africa.

His appointment, announced May 12 by UNESCO Director General Federico Mayor, represents several firsts in the organization's 50-year history of promoting collaboration among nations through education, science, culture, and communication. Diarra, who was born in Mali, West Africa, is the first ambassador originally from Africa, the first from the sciences, and the first American citizen to hold the post.

In his role as an ambassador for science and technology education, Diarra, who holds a doctorate in mechanical engineering from Howard University, Washington, DC, will be working toward establishing a university in Africa with a strong science curriculum. He also will be involved in efforts to raise public awareness of the importance of science and mathematics to global peace and technological advancement.

Diane Ainsworth
JPL/PIO

Pathfinder *(from p. 3)*

the west before the lander came to rest at its present location.

Five prominent horizon features and two small craters were identified in both lander horizon and Viking Orbiter images, enabling the lander to be located within 100 m of other surface features at 19.13°N, 33.22°W in the U. S. Geological Survey reference frame. Because the Pathfinder's location has also been determined in inertial space from two-way ranging and Doppler tracking results, it is the best-known location on Mars and provides a tie point for locating surface features on Mars.

Many characteristics of the landing site are consistent with its being a plain composed of materials deposited by the Ares and Tiu catastrophic floods. The rocky surface is composed of subangular to subrounded pebbles, cobbles, and boulders that generally resemble depositional surfaces produced in terrestrial catastrophic floods. The Twin Peaks appear to be streamlined hills in lander images, consistent with interpretations of Viking Orbiter images of the region, which suggest the lander is on the flank of a broad, gentle ridge or debris tail deposited in the wake of Twin Peaks. Rocks in the Rock Garden may be imbricated or inclined blocks generally tilted in the direction of flow. Troughs visible throughout the scene may be primary features produced by the flood, or they may result from the late-stage drainage of water after deposition. Large rocks appear tabular, subrounded, and many are perched, consistent with deposition by a flood. Except for eolian activity that may have deflated the surface by 5-7 cm, the site appears little altered since it formed up to a few billion years ago.

A variety of soil types have been found at the site and appear consistent with poorly crystalline or nanophase iron-bearing materials. Elemental compositions of soil units measured by the Alpha Proton X-Ray Spectrometer (APXS) are generally similar to those measured at the Viking sites. Because the Pathfinder and Viking landers are widely spaced, the similarities in soil

A closeup Sojourner image of a rock called Souffle at the Mars Pathfinder Landing Site

compositions suggest that the compositions are influenced by globally distributed materials on Mars, such as the airborne dust. The similarity in compositions among the soils implies that the differences in color may be due to either slight differences in iron mineralogy, differences in particle size and shape, or the fact that the soils are likely complex mixtures of a variety of weathering products

In general, the rocks are dark gray with discontinuous coatings of bright dust and/or weathered surfaces. The rock chemistry measured by the APXS is similar to basalts, basaltic andesites, and andesites on Earth. Generally linear relationships between the red/blue ratio of the rocks, their silica or sulfur content, and the average soil composition suggest that dark, high-silica rocks are coated with sulfur-rich dust. This relationship allows a dust-free rock composition to be calculated, which is andesitic in composition and distinct from the mafic and relatively silica-poor martian meteorites found on Earth. The chemistry and normative mineralogy of the sulfur-free rock are similar to those of common terrestrial anorogenic andesites, such as icelandites, which formed by fractional crystallization of mantle-derived parent materials. Rover close-up and lander images show rocks with a variety of morphologies, textures, and fabrics such as pitted, smooth, bumpy, layered, and lineated, suggestive of a variety of rock types. Some of the rocks may be conglomerates, composed of rounded pebbles with reflective hemispheric pockets or indentations where pebbles originally embedded in a finer matrix have fallen out. Rocks such as these could be the source of numerous loose rounded pebbles and cobbles on the surface. If the rocks are conglomerates, they require running water to smooth and round the pebbles and cobbles over long periods of time. The rounded materials would then be deposited into a finer-grained sand and clay matrix and lithified before being carried to the site. This evidence suggests a warmer and wetter past in which liquid water was stable and the atmosphere was thicker.

The magnetic properties experiment shows that airborne magnetic dust has been progressively deposited with time on most of the magnetic targets on the lander. The dust is light yellowish brown and has a magnetization and chemistry consistent with composite clay-sized silicate particles with a small amount of a very magnetic mineral, believed to be maghemite, as stain or cement. The favored interpretation of these results is that iron was dissolved out of crustal materials in water, suggesting an active hydrologic cycle at some time on Mars, and that the maghemite is a freeze-dried precipitate.

Observations of wheel tracks and soil mechanics experiments suggest that a variety of materials with different physical properties are present at the landing site. Rover tracks in bright drift material preserve individual cleat marks that are reflective, indicating compressible deposits of very fine-grained dust. Cloddy deposits appear to be composed of poorly sorted dust, sand-sized particles, lumps of soil, and small rock granules and pebbles. The interaction of these materials with the rover wheels indicates they are like soils on Earth with bulk densities near 1.5 g/cm^3. Intermittent thick coatings of dust on the rover wheels suggest that the dust becomes electrostatically charged when compressed.

The atmospheric opacity was measured at 0.5 and is slightly higher at night and early morning. The sky has been a light yellowish brown color, and particle size and shape and water vapor in the atmosphere are all consistent with measurements made by Viking. The upper atmosphere (above 60 km altitude) was relatively cold, although this may be consistent with seasonal variations and entry at 3 a.m. local solar time. The multiple peaks in the landed pressure measurements and the entry and descent data are indicative of dust uniformly mixed in a warm lower atmosphere, again similar to measurements made by Viking.

The meteorology measurements show repeatable diurnal and higher-order temperature fluctuations. The barometric minimum was reached at the site near sol 20, indicating the maximum extent of the winter south polar cap. Temperatures fluctuated abruptly with time and between 0.25 and 1 m height in the morning. These observations suggest that cold morning air was warmed by the surface and convected upward in small eddies. Winds have been light (< 10 m/s) and variable, peaking at night and during daytime. Dust devils have been detected repeatedly around midday and have been imaged; they may be an effective way of raising the fine-grained dust into the atmosphere.

Daily Doppler tracking and less frequent two-way ranging during communication sessions between the spacecraft and Deep Space Network antennas have resulted in a solution for the location of the lander in inertial space and the direction of the Mars rotation axis. Combined with earlier results from the Viking landers, this gives a factor of three improvement in the Mars precession constant. The estimated precession constant constrains the core radius to be larger than 1300 km but no larger than about 2000 km.

Taking all the results together supports an early Mars that may have been Earth-like. Some crustal materials on Mars may be similar in silica content to continental crust on Earth. The rounded pebbles and cobbles, the possible conglomerate, and the abundant sand- and dust-sized particles and models for their origin support a water-rich planet in which the early environment was warmer and wetter and liquid water was in equilibrium, perhaps similar to the early Earth. In contrast, during the past 2 to 3 billion years, Mars appears to be a very un-Earth-like place, with very low erosion rates producing minor changes to the surface at the Pathfinder landing site.

Dr. Matt Golombek
Mars Pathfinder Project Scientist

ASU Hires New Mars EPO Coordinator

The Arizona State University Mars K-12 Education Outreach Program is an educational project of the Thermal Emission Spectrometer group headed by Dr. Phil Christensen and housed in the Mars Global Surveyor Space Flight Facility on the ASU campus in Tempe. Ken Edgett served one-half time as the director for nearly six years and built the program into a cutting-edge, international outreach before taking a position with Malin Space Science Systems in California last spring. With the advent of the current and future Mars mission bringing a surge of interest in planetary sciences, Sheri Klug has been

Continued on next page

Mars Pathfinder IMP image of Sojourner near Chimp on Sol 72

ASU *(from p. 7)*

hired as the full time director of the program. Klug has been involved as a Mars educator in the Northwest for the past three years and has participated in educational outreach workshops and events for Mars Pathfinder and Mars Global Surveyor.

What's News *(from p. 4)*

face, will provide mirror-like facets that will reflect more energy back to the transmitter even when viewed at a slant. If the materials making up the martian surface are less dense, they will absorb more of the incident radio waves and thereby weaken the echo. These electromagnetic scattering phenomena allow us to probe the geomorphology and geochemistry of the martian surface and to map the observed characteristics along the radar tracks. The density of the surface and its roughness are related to rockiness, which we would also like to know before sending a retro-rocket lander with only 35-cm clearance to a target location. Thus, radar contributes to the selection of future Mars landing sites.

Because the orbits of Earth and Mars lie near a plane, subradar points on Mars are always in the martian equatorial region between 25 degrees north and 25 degrees south latitude. Thus, much of Mars is not directly probed by the radar techniques discussed here. One method that lends itself to a global picture of Mars in radar light involves illuminating the whole planet with a radar beam and then imaging the full disk with a radio telescope. This does not provide topography, but does let us study roughness and rockiness across the martian globe. The Mars Pathfinder landing site is among the rockiest on the planet. The robust airbag landing system allowed us to explore this highly interesting locale.

Dr. Albert Haldemann
Planetary Radar Group

Martians of the Month

Every month the Mars Exploration Program Office at the Jet Propulsion Laboratory honors employees who have made a significant contribution to the work of sending spacecraft to Mars. Here are the two most recent "Martians of the Month."

September: Eric Grant

Eric Grant, Mars Surveyor Operations Project Navigator, was the Martian of the Month for September. His timely and accurate analysis of the Doppler tracking data has resulted in the precise location and prediction of MGS's orbital motion. He has demonstrated extraordinary dedication over the entire 6.5-month aerobraking interval by working a daily schedule dictated by MGS orbital events and not the traditional rising and setting of the Sun.

October: Kathleen Spellman

Kathleen Spellman took over as Experiment Operations Team Leader on Mars Pathfinder in October 1997. She was responsible for all of the science team activities on Pathfinder, with the major emphasis being on assembling and formatting the data archives and developing the uplink system. When the uplink system was largely in place and settled, she was suddenly called upon to fill the role of Science Coordinator, a position that had been unexpectedly vacated. Throughout the project she always maintained her cheerful attitude and was always available to help anyone in need. Her hard work, dedication, unflagging project spirit, and many special talents and the enthusiasm she brings to the Mars Program make her truly worthy to be named Martian of the Month.

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